Defense Technical Information Center Compilation Part Notice

ADP010305

TITLE: Aircraft Life Extension - CC130 Hercules Avionics Update

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Advances in Vehicle Systems Concepts and Integration. [les Avancees en concepts systemes pour vehicules et en integration]

To order the complete compilation report, use: ADA381871

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, ect. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP010300 thru ADP010339

UNCLASSIFIED

Aircraft Life Extension - CC130 Hercules Avionics Update

Major C.P. Daley

National Defence Headquarters
DAEPM(TH) 5-3
MGen G. Pearkes Building
Ottawa, Canada
K1A 0K2

1. Summary

The Canadian Department of National Defence (DND), having taken measures to ensure the structural integrity of the CC130 Hercules to beyond 2010, studied a number of technical and economic options with respect to extending the life of its ageing CC130 Hercules avionics suite. The Department selected the option of a consolidated and comprehensive avionics update as the preferred option to ensure the aircraft can perform its missions with peak efficiency and that the avionics would meet or outlast the estimated life expectancy for the aircraft.

2. CC130 Estimated Life Expectancy

The structural life of the aircraft was not established at the time of design. The Canadian Department of National Defence (DND) has completed progressive wing replacement programs, and maintains ongoing Durability and Damage Tolerance Analyses, Aircraft Structural Integrity Program (ASIP), Progressive Structural Inspections (PSI), and Aircraft Sampling Inspections (ASI). Most recently, the DND has implemented a usage monitoring and fleet management program through installation of on-board data recording systems on the CC130 fleet. These systems will record actual load data, which can then be related to the specific flight profiles. In turn, fleet-wide usage and severity can be assessed, based on knowledge of the missions flown and the actual loads experienced during each mission.

Collectively these efforts aided in extending the estimated life expectancy (ELE) of the DND CC130 fleet to 2010.

3. Introduction - Avionics Update

The CC130 fleet is composed of six distinct Hercules models, each equipped with a different avionics configuration. These avionics variations ranged in nature from minor to significant and hinder flight crews from maintaining operational proficiency on all CC130 models. This imposed restraints on full-fleet utilisation during periods of maximum airlift requirement. Additionally, the majority of the aircraft in the fleet were fitted with certain avionics that would become obsolete and/or unsupportable prior to the ELE of 2010. In order for the CC130 to achieve its (structural) ELE of 2010 it was deemed necessary to replace or upgrade the fleet's avionics systems that could soon become unsupportable and/or not meet new international communication and navigation standards.

At the time of project initiation, over half of the DND CC130 fleet were 20-30 years old, with approximately 35000 flying hours. Notwithstanding their average age, the expense of replacing the fleet prior to the ELE of 2010 was discounted as a cost-effective means of resolving the avionics deficiencies and life-cycle shortfalls. It was considered essential from an operational and economic standpoint that all CC130 Hercules aircraft receive a standard and updated avionics suite.

Thus, to ensure that the CC130 continued to be an effective airlift resource until an ELE of 2010, these specific deficiencies were cited for resolution:

- the layout and type of flight-critical instrumentation is not standardized within the fleet, requiring specialized aircrew currencies to fly the various CC130 configurations;

Paper presented at the RTO SCI Symposium on "Aircraft Update Programmes. The Economical Alternative?", held in Ankara, Turkey, 26-28 April 1999 and published in RTO MP-44.

- current avionics systems will not meet the increasing navigation, communications, and identification requirements for the fleet's Strategic airlift, Search and Rescue (SAR), Tactical Air Transport (TAT), and Air-to-Air Refuelling (AAR) missions;
- a number of avionics systems, including the compass, the autopilot, the flight director, the doppler, and the communications suite, are unreliable, difficult to support, and in some cases no longer meet Regulatory and operational requirements;
- other systems, such as the radar display, are unreliable and difficult to support, despite being operationally suitable; and
- new systems such as Ground Collision Avoidance System (GCAS) enhance flight safety, and conform to new commercial regulatory requirements.

4. Option Analyses

4.1. Avionics Requirements Document

An Avionics Requirements Document[1] was developed to detail the requirements for the standard cockpit instrumentation and avionics suite. These requirements were based upon existing and documented operational CC130 missions and roles.

To document the derivation of the requirements for the standard avionics suite, an Avionics Mission Roles Analysis was conducted based on a top down analysis of the CC130 missions (strategic airlift, SAR, TAT, and AAR). An essential characteristic of all missions was worldwide, all weather. Category II Approach conditions. The missions were divided into individual segments, such as take-off, cruise, payload delivery, and approach. Each mission segment was then subjected to a detailed analysis to establish its requirements for the cockpit instrumentation and avionics systems.

Each mission segment underwent a detailed review relative existing specifications, standards, and regulatory requirements for these flight segments. Due to the integrated nature of civilian and military air operations, civilian specifications, standards and regulations were given equal consideration relative their military counterparts. Further, Canada is a signatory to many NATO standardization agreements (STANAGS) which directly relate to CC130 Hercules avionics requirements. The Avionics Requirements Document, and its Avionics Mission Roles Analysis, considered all of these requirements in detailing avionics requirements.

The results of the Avionics Mission Roles Analysis were collated and assigned to systems in six functional areas: navigation, communication, identification, flight control/guidance, on board systems, and self-protection. The most demanding requirements within each functional area were identified and associated with their supporting reference.

The Figure 1 illustrates the segmented, graphical nature in which avionics requirements were identified (navigation for strategic missions). Figure 2 depicts an example of the results for navigation (all missions).

4.2. Standard Avionics Specification

A Standard Avionics Specification[2] was then developed to detail the recommended standard avionics configuration for the DND CC130 fleet. It also initiated an economic analysis through calculation of rough order of magnitude procurement and installation costs for the implementation of the Avionics Requirement Document recommended avionics suite.

The avionics systems installed or planned for installation in DND CC130 Hercules, other DND aircraft, Lockheed production aircraft, and United States Air Force baseline Hercules aircraft, were researched and evaluated in terms of the identified avionics requirements and their supportability through to the ELE of 2010. Those systems, which were supportable and met appropriate avionics requirements, were recommended as candidates for the CC130 avionics update. These candidate systems were then synthesized into system options and traded-off in terms of technical and cost elements. Based upon the results of this trade-off, the

recommended standard avionics configuration was specified.

To ensure an objective evaluation of avionics requirements and supportability, each of the systems options were evaluated by development of an evaluation methodology based upon two summary evaluation factors; a technical figure of merit (TFOM) and a cost figure. When these two factors had been rated for each option, a recommendation as to the preferred option was identified.

Technical Figure of Merit. The TFOM was subdivided into evaluation elements, with each element mutually exclusive, and definable. An appropriate weighting factor was assigned to each element based on a direct estimation of the relative element priority. An assigned score of one to five was then multiplied by the weighting factor for that element, and "rolled-up" to provide an overall TFOM score. Evaluation elements and weightings were:

- **Capability** - the extent to which the system meets the requirements of the Avionics Requirements Document. Weighting 25;
- **Supportability** - the relative probability that the system will be economically supportable to the ELE of 2010. Weighting 25;
- **Availability** - relative reliability and maintainability of the system. Weighting 10;
- **Growth**; relative growth capability in terms of interface options, throughput and memory expansion. Also considered was the degree to which the system could be adapted to other aircraft within the DND. Weighting 5;
- **Commonality** - relative impact upon the DND Logistics System (training, publications, spares, test equipment). Weighting 15;
- **Risk** - relative risk of system development and integration for the CC130 Hercules application. Weighting 20;

Cost. For the summary cost factor, each of the following relevant cost elements were identified (Figure 3):

- **Fleet Equipment Cost** - the hardware and software costs to fit the Hercules fleet;
- **Non-Recurring Engineering (NRE) Cost** - the sum of one-time costs incurred in adapting the system hardware and software to the Hercules suite, and completion of installation design and prototyping. A factor of between 2 and 10 times the per aircraft installation costs was assigned;
- **Test & Support Equipment Costs** - test & support equipment costs for 1st (Organizational) and 2nd (Intermediate) level maintenance;
- **Initial Spares Costs** - in the absence of specific sparing recommendations, a value of 25% of fleet cost was assigned and 22% for dual installations;
- **Documentation Costs** - unilingual operations and maintenance documentation;
- **Training Costs** - initial operations and maintenance personnel training (exclusive of flight simulator modifications).

The result of the Standard Avionics Specification work was the identification of the preferred system, technically and financially, for each of the Avionics Requirements Document requirements (ie TACAN, VOR/ILS, VHF, UHF,...). The economic analyses performed through this Standard Avionics Specification work resulted in a rough order estimate of $90M (1989/1990 Canadian dollars) for the upgrade of the DND CC130 fleet. Lastly, the Standard Avionics Specification work concluded with the identification of future developments at Lockheed and within the United States Air Force which could impact upon the recommended avionics configuration (EFIS, FMS, and digital flight control system) and merit future consideration.

4.3. Avionics Update Development Study

A CC130 Avionics Update Development Study[3] was then completed, in consideration of the Standard Avionics Specification recommended systems, to compare and present the three preferred suite options for proceeding with a CC130 avionics update.

Since there were a significant number of individual avionics subsystems to be replaced, it would have been possible to identify innumerable options, differing only in the particular equipment proposed. The Avionics Update Development Study presented three broad options; these were:

- **Piecemeal approach** - whereby individual projects would be used as the vehicle for addressing both operational and maintenance requirements. Under this scenario, avionic equipment requirements would be addressed by individually staffed and managed stand-alone projects;

- **Lockheed standard** (Model 382C-63E) - At the time, this option reflected the configuration of the DND's latest CC130 aircraft, and would consist primarily of changing the older E and H Models to this avionics and cockpit configuration; or

- **CF baseline standard** - whereby all of the preferred avionic systems of the Standard Avionics Specification would be used, reflecting an operationally acceptable, cost-effective solution.

Analysis of the Options. Detailed analyses of the costs and performance capabilities of the options were conducted and were summarized within the Avionics Development Study. The piecemeal option would too slowly, if at all, resolve the critical problems, which gave rise to the project (Section 3. above). The two remaining options were determined to be essentially identical in their projected costs, however, the CF baseline standard was determined to:

- provide navigation and communication systems which will better meet new international standards;
- allow for future growth via an Interface Computer Unit (mixed data busses);
- incorporate newer systems which have higher Mean Time Between Failure (MTBF), resulting in improved serviceability;
- can also be implemented using currently available, off-the-shelf subsystems;
- provide greater reductions in 2nd (Intermediate) and 3rd (Depot) level maintenance support; and
- provide for substantially larger 1st level (Organizational) maintenance personnel savings.

The CF baseline standard was selected and approved as the recommended option.

5. Contract Development

5.1. Prime Item Development Specification

A Prime Item Development Specification was then developed from the Standard Avionics Specification to contractually describe the functional and regulatory requirements for the avionics suite. Through a period of almost two years, including a formal Request For Proposal phase, input from Industry was sought to best ensure that the resultant contract, and particularly the Prime Item Development Specification, would promote a successful, risk reduced, and cost efficient implementation. Notwithstanding this level of preparation, both the DND and the Prime Contractor continued to extensively amend the Prime Item Development Specification throughout the first year's conceptual and preliminary design phases; seeking further improvements, risk reductions and cost efficiencies.

5.2. Contract Award

After more than a year's liaison and negotiation with Industry, the CC130 AUP contract was awarded. The accuracy of the Standard Avionics Specification economic analysis' cost estimates proved sound as the prime contract award value was within the (upper) error estimate.

5.3. Modification Development

The development of the DND CC130 Hercules AUP modification closely followed the MIL-STD-1521 Systems Engineering process. In view of the extent of required integration and

software development, a Hot-Bench was manufactured and populated with all systems for the purpose of supporting these risk-inherent activities. In addition, the front section of a C130 Hercules (Flight Station 270 and forward) was acquired and also populated with all AUP systems to support design, development (particularly maintainability and Human Factors engineering), testing and initial training. Thirty-nine months were required from contract award through to prototype acceptance.

5.4. **Completed Modification**

The resultant DND CC130 Hercules AUP modification resulted in the following equipment installations:

- Aircraft Flight Control & Display System (civil):
  - Electronic Flight Instruments (Cathode Ray Tube),
  - Air Data sub-system,
  - Attitude and Heading Reference sub-system,
  - Autopilot sub-system,
  - Standby Instruments.
- Flight Management System (military):
  - Control Display Units,
  - Bus System Interface Units,
  - Remote (heads-up) Readout Units,
  - Emergency Control Panel,
  - Data Transfer sub-system (ARINC 424 data, etc).
- Display and Instruments System (military):
  - Navigation Data Display sub-system (radar display),
  - Ground Collision Avoidance sub-system.
- Self-Protection System (installed previous to the AUP):
  - Radar Warning Receiver sub-system,
  - Missile Approach Warning sub-system,
  - Countermeasures Dispensing sub-system,
- Navigation System (military/civil mixture):
  - Global Positioning sub-system,
  - Inertial Navigational Units,
  - VOR/ILS and Marker Beacon sub-system,
  - Automatic Direction Finder sub-system,
  - Identification Friend or Foe sub-system,
  - Distance Measuring Equipment sub-system,
  - Radar Altimeter sub-system,
  - Air Traffic Control Radio Beacon sub-system,
  - Multiband Direction Finder sub-system (distress frequencies),
  - TACAN sub-system,
  - VHF Direction Finder sub-system (distress frequencies).
- Communications System (military):
  - High Frequency sub-systems,
  - Combined Very High & Ultra High Frequency communication sub-systems,
  - Stand-alone Ultra High Frequency sub-system,
  - Secure Voice sub-systems,
- Recording System (civil):
  - On-Board Loads Monitoring sub-system,
  - Solid State Flight Data Recorder sub-system,
  - Solid State Cockpit Voice Recorder sub-system.
- Data Bus System (military/civil mixture):
  - MIL-STD-1553B sub-system,
  - all other data buses (ARINC, CSDB).

Through these extensive system installations, the project succeeded in the resolution of the original deficiencies that prompted the project:

- the layout and type of flight-critical instrumentation has been standardized for all models of Hercules within the fleet, greatly reducing any specialized aircrew currencies to fly the various CC130 aircraft;
- mission deficient systems have been replaced with new avionics capable of present and foreseen navigation, communications, and identification requirements for the aircraft's missions and roles;
- all systems which were not supportable to the ELE of 2010 have been replaced;
- all but one of the top ten maintenance intensive avionics systems were replaced with new systems with 10 times better

reliability (economic analyses of the one exception (radar) did not support replacement).

6. Aircraft Update - The Economical Alternative?

6.1. What Can and Cannot be Done Economically?

In a manner analogous to aircraft maintenance analyses, as conducted through the Maintenance Steering Group - 3 (MSG-3) logic within the DND, one must first determine which aircraft deficiencies are sufficiently critical that they require upgrades or replacements independent of economic factors. Of the remainder, where one has an option of continuing with the status quo, an economic study analogous to a Logistics Support Analysis (LSA) Level of Repair Analysis (LORA) is best conducted. Such a study will trade-off the increasing costs of the status quo, against the projected capital costs of upgrading/replacing and the anticipated future (reduction) of in-service operations and maintenance costs.

The DND CC130 AUP analyses in fact produced several cost/benefit results, which did not support upgrading, or replacement. Notably, the APN-59E radar is the most maintenance intensive avionic system on the CC130 aircraft. However, the radar meets all operational requirements and the cost to upgrade or replace the radar, even with projected maintenance/in-service cost savings, would not likely "pay-off" prior to the ELE.

Essentially, the Standard Avionics Specification and Avionics Development Study identified both the obligatory (operational and regulatory) requirements for the update, and further update recommendations where technical and economic analyses supported such changes.

6.2. What Are the Limitations to Extending the Useful Life of Aircraft?

Life extension of aircraft is ultimately a least common denomination function. Engineering and Maintenance seek the resources to push the lowest common denominator safely out to the calendar's right. This is, however, subject to the law of diminishing returns. Ultimately the year-over-year costs and marginal benefits of working to further extend the life of aircraft will not exceed the amortized costs and benefits of working to replace the aircraft. In this sense, aircraft systems may be the least common denominator precluding the cost-effective implementation of structural upgrades, or vice versa. For the DND CC130 AUP (circa 1990), the avionics were the least common denominator. As a result a cost-effective upgrade was identified and implemented to align the "life" of the avionics to the estimated life of the structure and remaining aircraft systems.

6.3. How Can Technological Advances Be Integrated?

Military procurements continue to evolve to commercial-off-the-shelf (COTS) products, which are increasingly driven by commercial specifications and standards[4]. These COTS products are subject to shorter, more rapid life cycles than their military predecessors[5]. Militaries are faced with early lifetime buys of systems and spares, or must plan to soon integrate upgrades and/or replacements.

Adding to this quickening evolution, are Regulatory changes, such as Traffic Collision Avoidance Systems, Ground Proximity Warning Systems, 8.33 MHz Channel spacing, Mode S transponders, Area Navigation, and GPS Receiver Autonomous Integrity Monitoring. The rapid technological advances of the computing and telecommunications industries are inducing derivative changes to the aerospace environment.

Shortened life cycles are making the requirement to add technological advances to not only in-service aircraft, but midstream within a Project, increasingly difficult to avoid. Apparent through the study of DND Capital acquisition projects, non-military, and international projects (F-16, USN Guided Missile Frigate, Oil Sands Extraction and Chemical Processing plants), is that average elapsed time for such projects is surprisingly similar: around 120 months. More over, the

elapsed time appears independent of the physical size of the end product, or even the nature of the project.[6] It was found that a project's duration is determined essentially by its complexity as measured by the degree of systems integration and by the degree of its physical and data-exchange linkages to other existing systems; production is typically the easiest phase. These time lines make it very probable to have to entertain design changes to include/integrate the latest technical advances. To reduce the potential design change complexity, plan on the likely systems integration and data-exchange linkages.

Avionics designs should be developed with the expectation to include and reserve space for such future additions. Thought must be given to:

- preferred, reserved, electromagnetically compatible antenna locations,
- interface computers capable of integrating both military and civil data bus standards,
- reserved avionics bay locations which maximize maintainability and reliability,
- electrical system capacity and spare components (circuit breaker locations, junction box access),
- procure systems which are likely to evolve in a form, fit, function manner for foreseen upgrades (GPS for RAIM/WAAS/LAAS),
- implement Logistic Support and Configuration Management processes that can easily adapt to upgrades and replacements.

7. Conclusion

In the early 1990's the Canadian Department of National Defence resolved that the CC130 Hercules avionics systems would limit the ability of the fleet to attain an ELE of 2010. Through a systematic process of technical and economic analyses, an Avionics Update Project was developed and approved to replace or upgrade a large proportion of the cockpit avionics. Though AUP modified aircraft have yet to complete a full year of in-service operations, capital expenditures and in-service logistics data thus far support the economic merit of updating avionics for mid-to-long term resource savings and aircraft life extension.

---

1 Electronic Warfare Associates - Canada, Ltd. **Avionics Requirements Document**, Prepared for the Department of National Defence, Contract W8465-8-AMNN/02-BQ, 30 November 1989

2 Electronic Warfare Associates - Canada, Ltd. **Standard Avionics Specification**, Prepared for the Department of National Defence, Contract W8465-8-AMNN/02-BQ, 20 August 1990

3 Department of National Defence, Report 32370-100-008 **Avionics Update Development Study**, 25 November 1991

4 Matthews, J. and Condra, L., **Avionics Magazine**, March 1999, "The Growing Problem of Component Obsolescence"

5 Sweetman, B. and Cook, N., **INTERAVIA**, January 1999, "Military Avionics: engine of change or obsolete relic?"

6 McFarlane, G., MGen (retd), Letter to Chief of the Air Staff, November 13, 1998

HIERARCHY OF FUNCTIONAL REQUIREMENTS (FOR STRATEGIC AIRLIFT) — REGULATION OR REQUIREMENT

- AA - Strategic Airlift/Standard
  - AAA - Navigation
    - AAAA - IFR
      - AAAAA - Reqr ADF or VOR or TACAN — CFP 100(1), Chap 5, Para 6
      - AAAAB - Nav without Ref to Earth/Water — CFP 100(1), Chap 5, Para 6
    - AAAB - Nav System Requirements
      - AAABA - Display/Control
        - AAABA - Avail Pilot/Co-Pilot/Nav Stns — DAR 3-5, 11500LT-1
        - AAABAB - Position of Pilot Operatied — NATO STANAG 3258
        - AAABAC - Minimum Quantity — DAR 3-5, 11500 LT-1
      - AAABB - Appropriate for ATC Req't — ICAO Annex 6, Part 1, 7.2.1
      - AAABC - ADF System Characteristics — ICAO Annex 10(1), Part 1, 3.9
      - AAABD - DME System Characteristics — ICAO Annex 10(1), Part 1, 3.5.
      - AAABE - VOR
        - AAABEA - System Characteristics — ICAO Annex 10(1), Part I, Att C
        - AAABEB - Interference Immunity — ICAO Annex 10(1), Part 1, 3.3.8
      - AAABF - ILS
        - AAABFA - System Characteristics — ICAO Annex 10(1), Part I, Att C
        - AAABFB - Interference Immunity — ICAO Annex 10(1), Part 1, 3.1.4
      - AAABG - TACAN System Charateristics — NATO STANAG 5034
      - AAABH - True/Mag/Grid Nav Capability — DAR 3-5, 11500LT-1
      - AAABJ - Redundancy — DAR 3-5, 11500LT-1; ICAO Annex 6, Part 1, 7.2
      - AAABK - Integration
        - AAABKA - Requirement — DAR 3-5, 11500LT-1
        - AAABKB - Sensor Reinitialization In-flight — DAR 3-5, 11500LT-1
      - AAABL - One Self-Contained Nav Sys — DAR 3-5, 11500LT-1
      - AAABM - Operate at LAT up to 82 Deg N — DAR 3-5, 11500LT-1
      - AAABN - Operate at Temps to -50C — DAR 3-5, 11500LT-1
      - AAABP - Max 20 Min Until Full Nav Capability — DAR 3-5, 11500LT-1

FIGURE 1

CC130 Avionics Update - Life Extension

NAVIGATION SYSTEM REQUIREMENTS	REQUIREMENT
VOR Receivers	2
ADF Receivers	2
TACAN Receiver (Includes DME Capability)	X
Air-to-Air TACAN Station Capability	X (KC130 Only)
Radar for Weather Avoidance, Ground Mapping, and Formation Station Keeping	X
ILS Glideslope and Localizer Receivers	2
Radar Altimeter	X
Cockpit Display of Drift and Ground Speed	X
Marker Beacon Receiver	X
Horizontal Position Accuracy (2 drms)	+/- 50 Meters
Altitude Accuracy (AGL, 2 sigma, below 800 Feet)	+/- 10 Feet
One Self-Contained Navigation System	X
Minimum Navigation Performance Specifications Certified	X
Wind Speed and Direction at Aircraft Altitude	X
Pattern Flight Navigation Capability	X
Emergency Frequency Direction Finding Capability	X
Integrated Navigation System	X
True/Magnetic/Grid Navigation Capability	X
Displays and Controls Available at Pilot, Co-Pilot and Navigator Stations	X
Capable of Operating at 82 Degrees North Latitude	X
Maximum 20 minutes from Aircraft Power Application Until Full Navigation Capability	X
Capable of Operating With Ramp Temperatures to -50 Degrees Celsius	X
Continuous Indication of Track Position to Flight Crew	X
Global Positioning System Receiver	Future
Microwave Landing System Receiver	Future

FIGURE 2

CC130 Avionics Update - Life Extension

SYSTEM: ARN-127 VOR/ILS/MB System

COST DATA SOURCE: DND

COMMENTS: It is assumed that the existing antenna would be used.

FLEET EQUIPMENT COST: $303,,300

Item	Quantity per System	Cost (each)	Total Cost
Receiver	1	$13,300	$13,300
Control	1	$3,000	$3,000
Mount	1	$550	$550
			$16,850

	CC1130 Aircraft Model				
	E	H	H(73)	H(84)	H(89)
System Quantity Currently Installed	2	2	0	0	0

Fleet Equipment Cost = System Cost x Quantity per Aircraft x Number of CC130 AC to be fitted
= $16,850 x 2 x 9
= #303,300

FLEET STAND-ALONE INSTALLATION COST: $421,875

Fleet Stand-Alone Installation Cost = Installation Man-hours x labour Rate x Quantity per Aircraft x Installation Kit Multiplication Factor x Number of CC130 AC to be fitted
= 250 x $75 x 2 x 1.25 x 9
= $421,875

NON-RECURRING ENGINEERING (NRE) COST: $93,750

Estimated to be 2 times the installation cost for one aircraft, as already installed in the majority of CF Hercules fleet. Equates to 2 x $46,875, or $93, 750.

TEST & SUPPORT EQUIPMENT COST: $0

Nil, existing CF support equipment sufficient

INITIAL SPARE S COST: $66,726

Initial Spares Cost = 22% x Fleet Equipment Cost
= 0.22 x $303,300
= $66,726

DOCUMENTATION COST: $0

Nil, already in CF inventory and installed in CF Hercules aircraft.

TRAINING COST: $0

Nil, already in CF inventory and installed in CF Hercules aircraft

TOTAL PROCUREMENT COST (sum of above costs): $885,651

FIGURE 3

CC130 Avionics Update - Life Extension

CC130 Problem Systems

Function	System (Note 1)	Maint Hrs /1000 Flt Hrs (Note 2)	MTBF Hrs (Note 2)	Ops Effect % (Note 3)	In Production	Support to 2010 (Note 4)
Radar	APN-59F	314	56	17	No	Low
Recorder	USH-502(V)1	251	69	4	No	Low
DVS	APN-501A	179	98	3	No	Low
Autopilot	E-4	119	112	4	No	Low
Compass	C-12	97	109	12	Yes	High
Rad Alt	APN-150	91	306	1	No	Low
Nav Computer	ASN-504	80	115	4	No	Low
IFF	APX-77	79	158	9	No	Low
Nav Computer	AYN-501	75	129	1	No	Low
Omega	ARN-509	57	264	3	No	Low
Flt Director	MA-1	53	112	28	No	Low
ADF	ARN-6	48	293	1	No	Low
Comm HF	ARC-505	46	327	3	No	Low
Rad Alt	APN-133	34	434	0	No	Low
Astral Compass	SAC	28	390	4	No	
TACAN	ARN-504	28	555	1	No	Low
UHF DF	ARA-25/50	10	2100	0	No	Low

Notes:

1. Systems shown if MTBF is less than 400 hours or there is a low probability of support to the year 2010.

2. Figures based on Aircraft Maintenance Management Information System data. Equipment installed on only a few aircraft is not included because of small sample size.

3. Figure indicates the percentage of all avionics failures causing an abort, delay or reduction to a mission.

4. Assessment of supportability to 2010 is taken from the Electronic Warfare Associates - Canada Standard Avionics Specification, July 1990.

FIGURE 4

CC130 Avionics Update - Life Extension